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SUMMARY REPORT

ON

TASK ORDER NO. JJ

November 25, 1959

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March 17, 1960

Dear Sir:

Enclosed is the "Summary Report on Task Order No. JJ", which describes the research performed under this Task Order, during the period June 26 through November 25, 1959.

The objectives of the research were to evaluate the suitability of selected, commercially available small incinerators for use in the destruction of security-classified office papers and documents. Distinct differences among seven different units were measured or observed when the units were operated in a number of different ways. In nearly all cases, the rates of burning attained were undesirably low. The safety, reliability, and life expectancy of all of the units seemed satisfactory.

We would appreciate your handling discreetly the performance data in association with the specific units, as well as the information regarding our role in conducting this evaluation, in view of our relationship with the manufacturers of such units, as discussed with you previously.

We would appreciate any comments which you or your associates might care to make with regard to the Task Order No. JJ evaluation.

Sincerely,

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**TASK ORDER NO. JJ**

**November 25, 1959**

**CONFIDENTIAL**

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## SUMMARY REPORT

ON

TASK ORDER NO. JJ

November 25, 1959

INTRODUCTION

In recent years, a number of small, domestic, gas-fired incinerators<sup>(1)\*</sup> have been developed, and today are available on the market for use in incinerating domestic garbage and paper without undesirable associated odors, fly ash, and the like. In view of a need for suitable equipment and techniques for destroying security-classified papers and documents, the Sponsor was interested in investigating the possible applicability of the above-described type of incinerators and of other small industrial and special-purpose incinerators to his objectives. Consequently, a program was set up under Task Order No. JJ with the objectives of investigating the performance and characteristics of selected small, commercially available incinerators, and then on the basis of the data obtained, evaluating these units for use in destroying papers and documents.

This report summarizes the research conducted under Task Order No. JJ, during the period from June 26 through November 25, 1959.

\*Superscript numbers in parentheses refer to items listed in the "References".

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SUMMARY AND CONCLUSIONS

Seven representative, small commercially available incinerators were selected, procured, and set up for individual operation in a small room simulating typical office space. These included five domestic gas-fired garbage incinerators each with a capacity of about 1-1/2 bushels, namely, the Calcinator, Caloric, Warm Morning, and two Martin units; one specialized paper burner with a 1-1/2-bushel capacity, namely, the Silent Glow Confidential Paper Destroyer; and one small industrial garbage and burnable-refuse incinerator with a 4-bushel capacity, namely, the Wincinator.

A total of 43 working-day-long burning experiments were run in these incinerators under a variety of planned operating conditions to investigate the performance and characteristics of these units with respect to their suitability for the destruction of security-classified papers and documents. The major factors considered in the evaluation of the suitability of these units for this specialized use were (1) burning rate, (2) degree or completeness of destruction, (3) extent of smoke, dust, and odor emitted into the room, (4) intensity of associated heating of the room, (5) emission level of the smoke and fly ash in the flue gases, and (6) durability including estimated life expectancy, and safety, convenience, and reliability of operation.

The results of this evaluation indicated that under certain conditions, or with a tolerance for selected limitations, some of the small, domestic, gas-fired incinerators would be suitable for the destruction of papers and documents within the environment represented by typical buildings. However, under any single mode of operation that was

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investigated, the various performance factors were not all simultaneously favorable. Consequently, it is expected that compromises in some of the factors such as maximum burning rate would have to be tolerated in order to attain better acceptability with respect to the other factors.

The major disadvantage in the performance of all seven of the units was their inability to achieve complete destruction of legible residue by the end of an 8-hr day, despite frequent manual poking during the later hours of the burning period. Charging a relatively full load of stacked paper only once at the beginning of the day resulted in a decreased daily burning capacity, but the degree of destruction was more complete than with intermittent feeding. This method of single-batch operation was also safer and cleaner, and led to the smallest stack emission of fly ash. Continuous operation of even the smaller units throughout the day in a small air-conditioned room caused an appreciable rise in room temperature, with associated discomfort to the personnel working in the room. Under service conditions, the extent of this problem would depend on the size of the room, the shielding provided for the unit, and the amount of cooling or ventilation in the room.

In general, aspects relating to safety, durability, convenience, and reliability of operation were acceptable for all seven of the units. Estimated life expectancy would be about 5 years for these units under daily use, although on some of the units certain selected metal parts exposed to high temperature in the normal operation would probably have to be replaced after about one year of steady use. Replacement of such parts could be performed readily.

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At least one of the domestic gas-fired units, the Calcinator, and possibly others, appeared to be suitable for this specialized use providing that (1) the desired maximum burning capacity per unit was approximately 20 pounds of paper per 8-hr day; (2) special precautions were taken to insure maximum burnout of the residue by poking, followed by examination and breaking up of the remaining pieces of legible char and ash at the end of the day; and (3) heating up of the room could be tolerated or could be minimized by the appropriate location of unit, by suitable dissipation of the heat, or by some other measures.

The Silent Glow Confidential Paper Destroyer appears to be somewhat better suited for this application than the domestic gas-fired units; this unit is more suitable particularly in regard to burning capacity and degree of destruction, and the advantage that the operator would be able to leave the residue securely in the padlocked unit overnight and to complete the destruction of this material along with a new charge on the following day. A daily burning capacity of about 40 pounds was obtained for the Silent Glow unit by charging two 20-pound loads per day. If operation overnight on a charge was permitted in the locked unit, a third load could be charged and destroyed in the course of the after-work-hour period. The problem of the Silent Glow unit heating the room would be similar to that for the domestic units. The fact that gas is not involved as an auxiliary fuel in the operation of the Silent Glow would represent a definite advantage in most instances.

The 4-bushel Winsinator presents a serious problem in overheating a small room. Therefore, it should be considered for use only in a

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suitable area where the associated heat could be tolerated or could be dissipated by special provisions. Daily burning capacities of from 100 to 200 pounds were achieved in the Wincinator, depending on the kind of auxiliary burner equipment in operation on the unit. With a blower in operation on the Wincinator, a high burning rate was achieved; however, the emission of fly ash in the stack gases was more noticeable than in the case of the smaller domestic units, and might not be tolerated under the limitations imposed by some municipal air-pollution codes in the United States.

The burning capacities mentioned above for the Wincinator can be increased by about 50 per cent for emergency use by crumpling the paper and feeding intermittently throughout the day. However, under such conditions, some of the desirable features of operation would, of necessity, be sacrificed.

It is of interest that the burning capacities for the various units were proportional to the costs of the units. Also, the cost of natural gas for operation of the domestic gas-fired units would be about 20 cents per 8-hr day (based on gas at 70 cents per 1,000 cu ft), and for the Wincinator, less than 50 cents per 8-hr day. The operation of the domestic units on Liquefied Petroleum (propane) gas (at 10 cents per lb) would cost about \$1.30 per 8-hr day for the fuel, and for the Wincinator, about \$3.00 per 8-hr day.

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DESCRIPTION OF INCINERATORS

The units for this evaluation were chosen on the basis of the combined judgement of the Sponsor and of our staff members. In the course of selecting these units, inquiries were sent to 24 known manufacturers, as listed in Appendix B. The replies, including brochures and advertising literature, were subsequently forwarded to the Sponsor. Seven units were purchased and operated during the program.

Figure 1 is a photograph of six of the incinerators. All of the units shown have a loading capacity of about 1-1/2 bushels. Four of the five domestic gas-fired units (Calcinator, Caloric, and two Martin units) are typical of the improved smokeless, odorless models developed recently by the American Gas Association<sup>(1,2)</sup> and cooperating manufacturers. The fifth, also a conventional domestic gas-fired unit (Wern Morning, Model L-17EF), was included because it is representative of the older types which are still available, but which do not comply<sup>(3)</sup> with the revised Approval Requirements of the American Standards Association<sup>(4)</sup> for reduced emission of smoke, odor, and fly ash.

The domestic gas-fired incinerators have an attractive appearance, are relatively small (about 2 by 2 by 3 ft), are light weight (130 to 250 lb), and are reasonable in cost (under \$200). They are shipped fully assembled in a crate, and require only a conventional connection to a gas main and a connection with 6-in.-diameter galvanized sheet-steel pipe (stove pipe) to an existing chimney or a flue pipe extending through a window or wall to the outside. About a 10-ft length of vertical flue pipe or chimney above the unit is needed to provide natural draft. For

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Figure 1. Photograph of Six Small Incinerators Selected for Evaluation

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normal installation where there would be an existing chimney and gas main nearby, about 4 man-hours of time would be required to uncrate, install, and put a unit of this type into operation. The manufacturer's instructions for installation are supplied with each unit. Further information with regard to proper installation of incinerators can be found in the National Board of Fire Underwriters (NBFU) Pamphlet No. 82, or in an identical text of the National Fire Protection Association, NFPA No. 82.

The cost of natural gas for operation of the domestic gas-fired incinerators would be about 20 cents per 8-hr day on the basis of the gas costing 70 cents per 1,000 cu ft. On the basis of 10 cents per lb of Liquefied Petroleum (propane) gas, the operation of the domestic units would cost about \$1.30 per 8-hr day for this type of fuel.

Figures 2 through 6 are photographs of the individual domestic gas-fired incinerators evaluated in this study. Descriptions of these units are presented in the following:

(1) Calcinator, Model 8-GHX-3P (shown in Figure 2)

New domestic smokeless-odorless type; 1.5-bushel loading capacity; 30,000 Btu per hr gas input; 100 per cent shut-off safety pilot; 4-hr automatic timer valve; sheet-metal liner; foil-backed glass-fiber insulation in cabinet; 130-lb shipping weight; retail price \$160; manufactured by the Calcinator Corporation, Bay City, Michigan.

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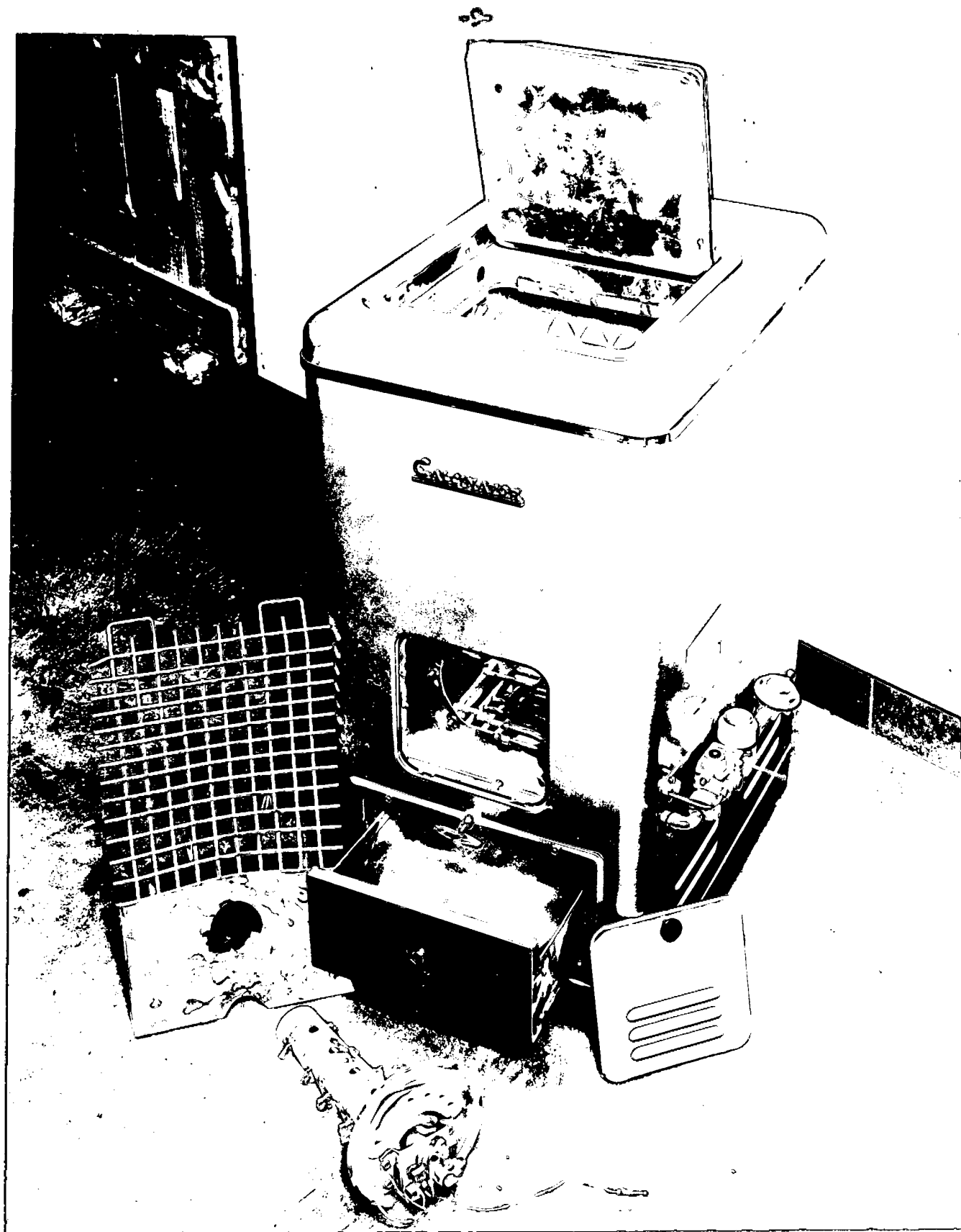


Figure 2. Photograph of the Galileometer, Model G-201-37,  
Portable Radiometer (After Evaluation)

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The burner, burner canopy, and rear baffle were removed from the unit and displayed as shown in Figure 2 to illustrate points which will be discussed later in this report.

(2) Caloric, Model 20 (shown in Figure 3)

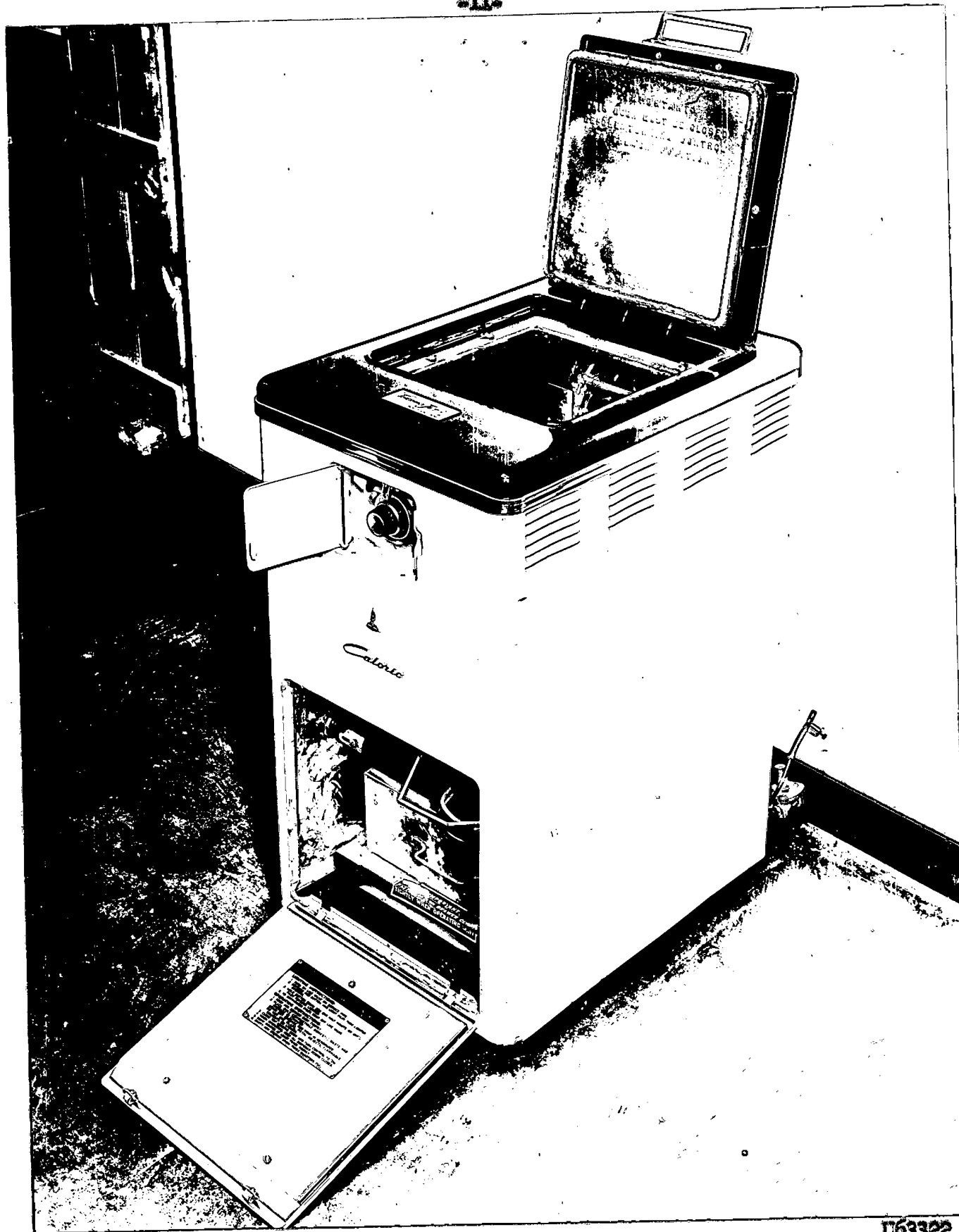
New domestic smokeless-odorless type; 1.5-bushel loading capacity; 32,000 Btu per hr gas input; 100 per cent shut-off safety pilot; 2-hr automatic timer valve; sheet-metal liner; foil-backed glass-fiber insulation in cabinet; 155-lb shipping weight; retail price \$150; manufactured by the Caloric Appliance Corporation, Topton, Pennsylvania.

This unit is equipped with a latch which locks the loading door when the burner is turned on. In order to permit intermittent batch feeding of paper for this evaluation, the latch was disconnected.

(3) Martin, Model B-59B (shown in Figure 4)

New domestic smokeless-odorless type; 1.5-bushel loading capacity; 35,000 Btu per hr gas input; 100 per cent shut-off safety pilot; 4-hr automatic timer valve; refractory-brick liner; no insulation in cabinet; 242-lb shipping

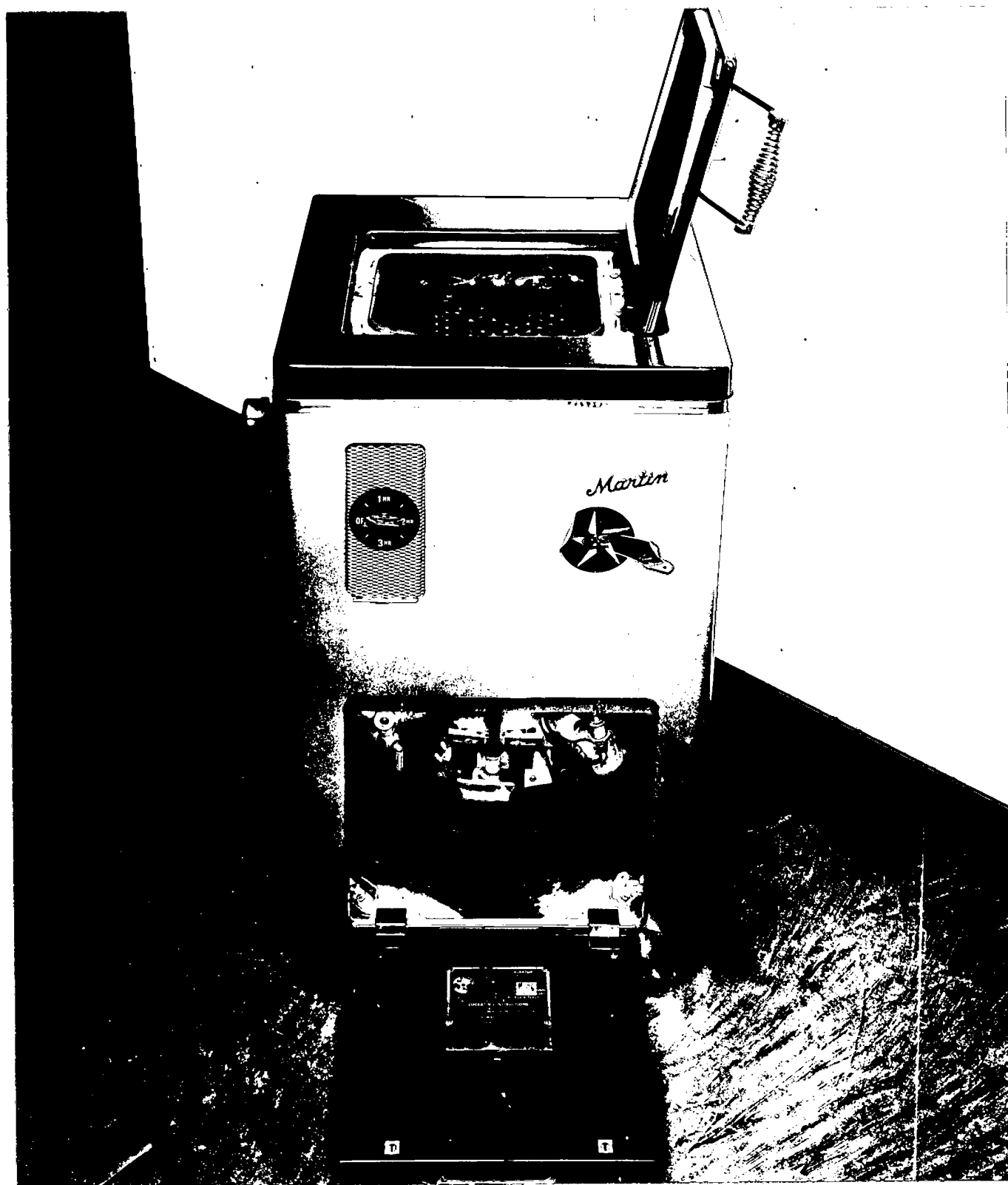
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Figure 3. Photograph of the Caloric, Model 20,  
Domestic Instrument (After Evaluation)

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Figure 4. Photograph of the Martin, Model S-59B,  
Domestic Incinerator (After Evaluation)

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weight; retail price \$175, which included a small manually powered blower installed on one side of the unit by an incinerator sales and service organization; manufactured by the Martin Stamping and Stove Company, Huntsville, Alabama.

(4) Martin, Model 4416 (shown in Figure 5)

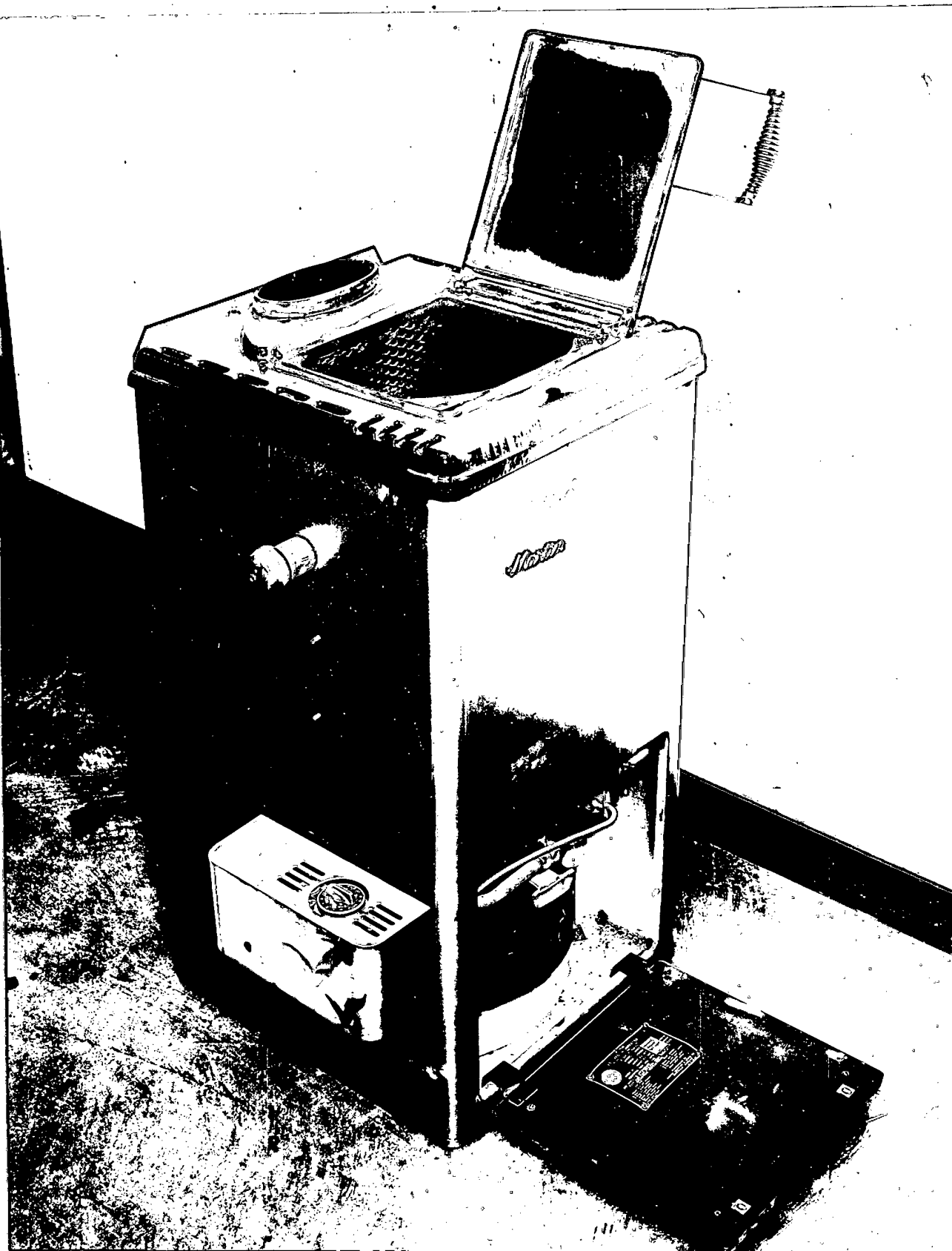
New domestic smokeless-odorless type; 1.5-bushel loading capacity; 35,000 Btu per hr gas input; 100 per cent shut-off safety pilot; 4-hr automatic timer valve; ceramic-coated sheet-metal liner; no insulation in cabinet; 166-lb shipping weight; retail price \$190, which included a blower as described above under Martin, Model S-59B and also an outdoor installation kit; manufactured by the Martin Stamping and Stove Company, Huntsville, Alabama.

(5) Warm Morning, Model L-17BT (shown in Figure 6)

Conventional (older type) domestic gas-fired unit; 1.7-bushel loading capacity; 10,000 Btu per hr gas input; 100 per cent shut-off safety pilot; 4-hr automatic timer valve; refractory-brick liner; no insulation in cabinet; 250-lb shipping weight; retail price \$100; manufactured by the Locke Stove Company, Kansas City, Missouri.

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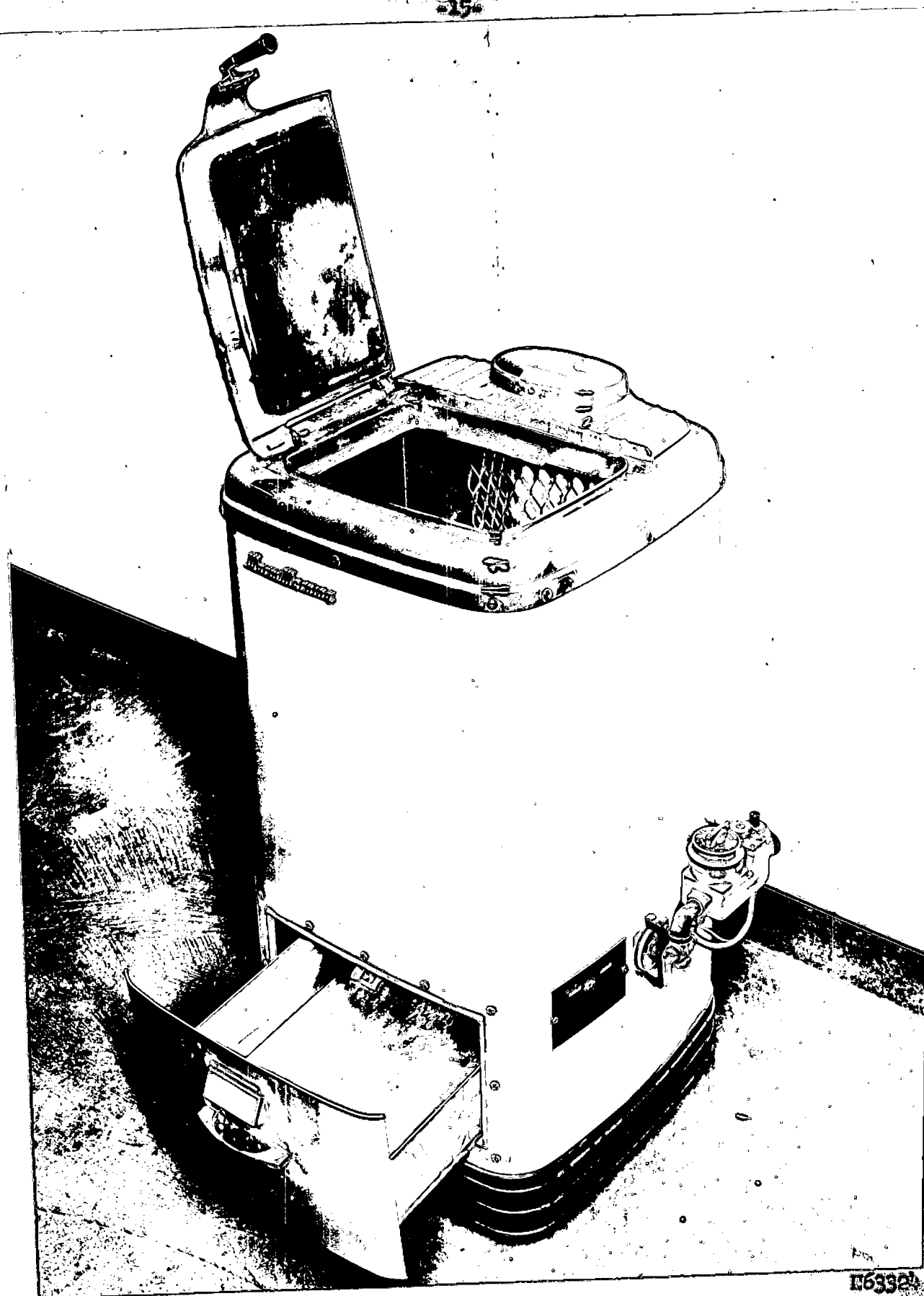


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Figure 5. Photograph of the Martin, Model M16,  
Dismote Insulator (After Evaluation)

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Figure 6. Photograph of the Egan Molding, Model L-17BE,  
Dismountable Incinerator (After Evaluation)

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Because of its apparent suitability for the destruction of paper without the need for auxiliary fuel, the Silent Glow Confidential Paper Destroyer (Figure 1) was included in this evaluation. Several sizes ranging from 1-1/2 to 30 bushels in loading capacity are manufactured by the Silent Glow Corporation, Hartford, Connecticut; the 1-1/2-bushel unit was selected for evaluation.

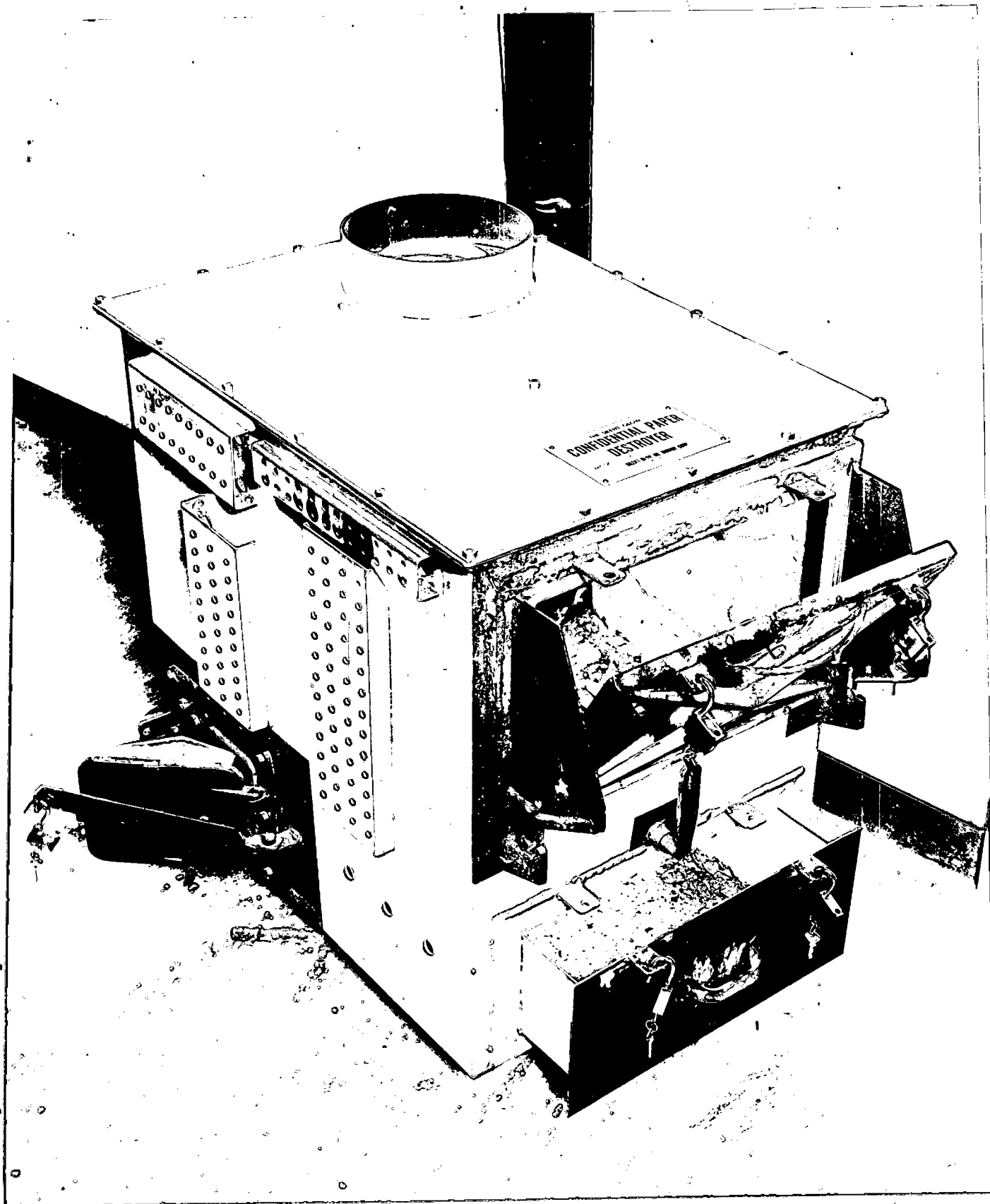
Figure 7 is a photograph of the 1-1/2-bushel Silent Glow unit, which is approximately 2 ft wide by 3 ft deep by 3 ft high. It is a specialized paper-burning incinerator with provisions for padlocking all of the openings except the flue outlet. The entire unit is lined with cast-in-place refractory, which makes it relatively heavy (shipping weight 700 lb). The retail price is \$345. For outdoor installation, a short stack and spark arrester can be obtained from the manufacturer. For indoor use, a barometric damper (draft control) is furnished, and about a 15-ft length of vertical stack is required to provide adequate draft. Installation of the assembled unit, as shipped in a crate, would require about 4 man-hours. Additional time, depending on the location, would be needed to install a flue pipe if there was no existing chimney.

Although auxiliary fuel is not needed to sustain burning in the Silent Glow unit, the installation manual recommends that the unit be preheated by burning wood or crumpled paper before solid-packed paper is charged. The burning-capacity information provided by the manufacturer indicates that loose material can be burned at the rate of 1-1/2 bushels per hr, and that packed material such as telephone books would require about 5 hr for a 1-1/2-bushel load.

Figure 8 illustrates a somewhat larger incinerator, the Wincinator, Model C2-4, 4 bushel, which is the seventh of the group evaluated. This

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Figure 7. Photograph of the Silent Glow Confidential Paper Destroyer, 1-1/2 Barrel (After Evaluation)



Figure 8. Photograph of the Winston, Model G2-b,  
Installed in the Test Room (After Evaluation)

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unit is typical of the smaller sizes of a class of incinerators used by commercial and industrial organizations for the disposal of garbage, paper, and other burnable refuse. Incinerators of this type are usually available with auxiliary gas-burning equipment, which can be installed as an afterburner or as a primary burner. The unit obtained for this evaluation was purchased with a power burner (forced gas-air mixture) installed as a primary burner to deliver a blast of flame through a sidewall against the charge of paper. This unit also had a simple gas burner which supplied flame at the grate level.

The Wincinator is approximately 3 ft wide by 4 ft deep by 5 ft high. The combustion chamber was lined with 3-in.-thick refractory slabs inside a sheet-metal housing. The secondary chamber, above and to the rear, was fitted with refractory baffles to provide a settling chamber for fly ash. The air for combustion entered through a damper in the ash-pit door and also through the power-burner port. A 10-in.-diameter stack having at least 15 ft of vertical length was required to provide adequate draft. The controls and adjustment on the gas burners allowed for a range of auxiliary gas-heat inputs of from 25,000 to 150,000 Btu per hr. The manufacturer's rated burning capacity is 75 lb per hr based on burning a mixture of half wet and half dry refuse. The cost of natural gas for the Wincinator would be less than 50 cents per 8-hr day, based on gas at 70 cents per 1,000 cu ft; the cost of Liquefied Petroleum (propane) gas would amount to about \$3.00 for an 8-hr day.

The Wincinator is usually received "knocked down" and is generally expected to be assembled at the site; but, if desired, the manufacturer will ship this unit completely assembled on a steel base plate. The installation

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time for the "knocked down" unit is about 16 man-hours. Four men are needed to lift the top section into place; the shipping weight of the entire unit is 650 lb. The Model C2-4 Wincinator with power burner as shown in Figure 8 cost \$760. It is manufactured by the Winnen Incinerator Company, Bedford, Ohio.

It is important to remember that in the installation and use of any incinerator or combustion device, provision must be made to insure an over-all adequate supply of air for combustion in the unit and for ventilation of the room in which the incinerator is located. Openings to the outside to permit infiltration of air should have a free cross-sectional area at least as large as that of the flue pipe installed on the incinerator for all natural-draft units, such as those involved in this evaluation. In addition, the usual precautions of having the flue pipe or chimney extend above the highest level of the building in which the unit is located should be followed if possible. If this is impossible or impracticable, other means for supplementing the natural draft so as to avoid downdrafts (the reversal of flow in the flue pipe) can be provided as described later in this report.

#### LABORATORY EVALUATION METHODS

In the laboratory evaluation of the seven above-described incinerators, each unit was set up in a laboratory space generally similar to an office space, and then operated in working-day-long tests by burning papers typical of those found in office files. The space selected was a room 11 by 22 ft, with a 9-ft-high ceiling, on the top floor of a four-story building.

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Figure 9 is a photograph of the test setup in this room. A window-type air conditioner was installed in the lower half of the window of this room. Panes of glass were removed from the upper half of the window to provide an exit for the flue pipes.

Figure 10 is a photograph of the outside of part of the four-story building and shows the 6-in.-diameter and the 10-in.-diameter flue pipes which were installed for this evaluation. The elevator penthouses, on the right and left sides of Figure 10, extended above the top of the two flue pipes. A metal sheet, painted black, was installed above and to one side of the 6-in.-diameter flue pipe to provide a suitable background for visual observations of smoke and fly ash during operation of the units.

Because of the relatively short stacks used and the likelihood of similar installations being used in the field, difficulties with downdrafts from eddy currents on the leeward side of adjacent structures were anticipated and were actually experienced. Therefore, a simple device, a draft inducer, was used in the test setup to insure adequate draft for the outward flow of the flue gases. This device consists of a small squirrel-cage electric blower (110 watts maximum) which introduces a jet of air axially into the horizontal section of the flue pipe at the elbow just above the incinerator, as shown in Figures 8 and 9. The device functions as an ejector and overcomes the back pressures which stem from either downdrafts or the slightly lower-than-atmospheric pressure which may exist in the building. The direct effect of this device on the burning rate and other performance factors was negligible, as was shown in this evaluation. Other types of draft inducers are available commercially.

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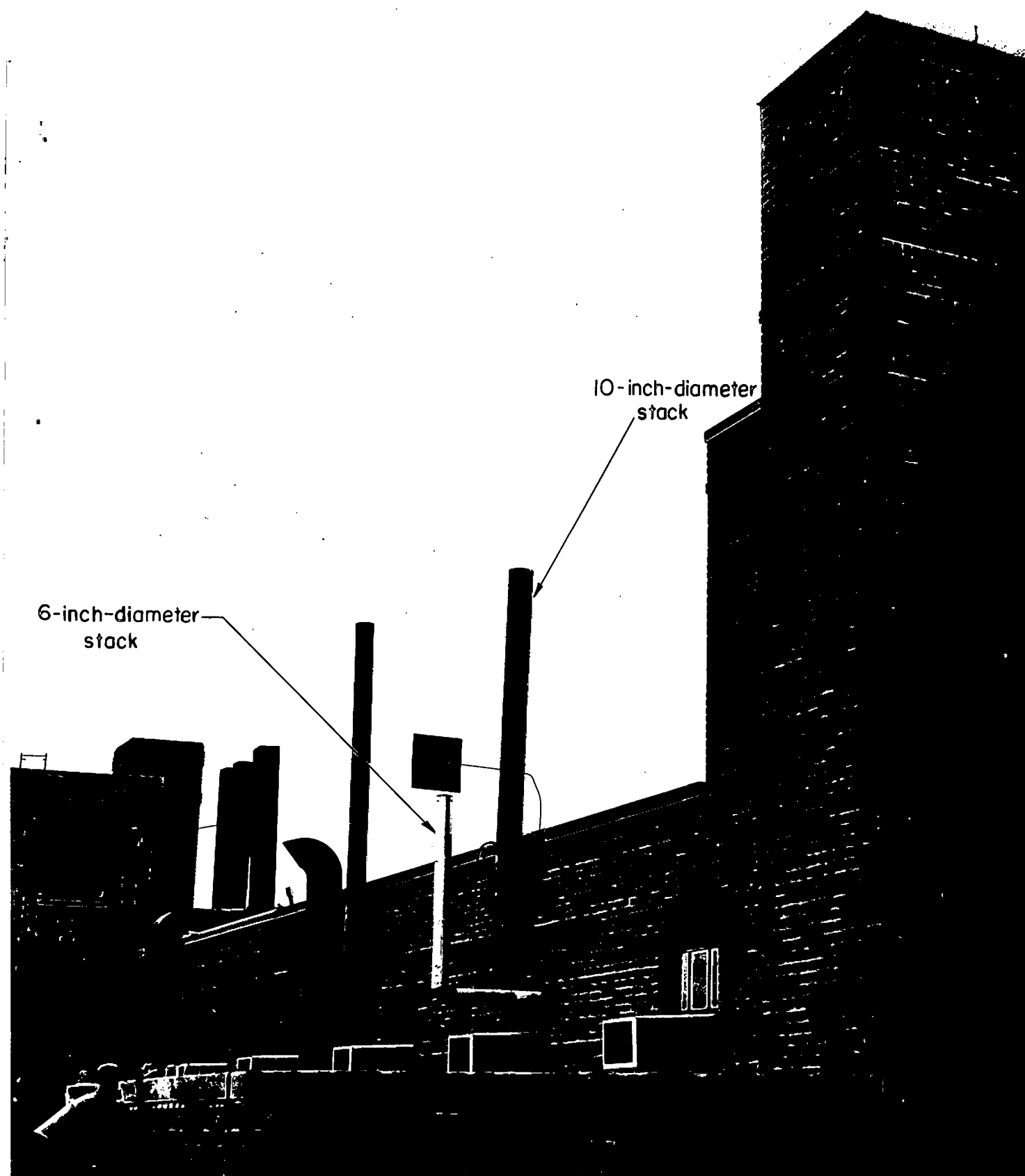
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Figure 9. Photograph of Test Setup for Evaluation of Domestic Incinerators

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**Figure 10. Photograph of Flue Pipes Outside of Building**

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For this application, any booster used must be capable of withstanding occasional flue-gas temperatures of over 1000 F.

Figures 8 and 9 also show the equipment and instrumentation used.

These included the following:

- (1) All of the incinerators except for the Wincinator were mounted on a platform scale to facilitate determining the burning rate over any selected period of time and the amount of unburned residue at the end of the daily burning period; only average-burning-rate data on a daily basis were obtained for the Wincinator.
- (2) The flow rate of natural gas to the burner was measured with a rotameter.
- (3) An inclined manometer was used to measure draft (negative pressure) in the flue pipe just downstream from the unit.
- (4) A 12-point temperature recorder and Chromel-Alumel thermocouples were used to measure (a) the flue-gas temperature, (b) the surface temperature at three of the hottest areas on the exterior of each unit, (c) the temperature of the hottest interior metal part of the combustion chamber, and (d) the temperature of the test room and of a similar, immediately adjacent room. Both the test room and the other room were equipped with the same kind of window-type air-conditioning unit; when both of the

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air-conditioning units either were or were not operating, the difference between the temperatures of these two rooms indicated the heating effect of an operating incinerator on the environment.

- (5) The emission of smoke from the stack was measured with a Bacharach Smoke Meter (described in a footnote to Table 1A of Appendix A); the emission of fly ash was judged visually.

During each test, observations were made regarding any odor in the stack gas and in the test room. The amount and the legibility of the unburned residue were determined after each daily operating period. Any malfunction or indication of severe operating conditions and warpage of parts was also noted.

During the first 14 test runs in the course of the experimental work, several types of paper including onionskin sheets, file cards, shredded newspaper, and telephone-book paper were burned in two of the domestic units under various loading methods; one of the objectives of these tests was to provide a basis for establishing suitable and uniform operating procedures which would permit a direct comparison of the results for all of the units included in the evaluation. As a result of these trial runs, telephone-book paper was selected for use in the bulk of the evaluation work because it was generally similar in burning characteristics to file papers and provided the desired uniformity of paper for day-to-day burning in all of the units. Miscellaneous papers discarded from our files were also burned in a few test runs.

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Each burning test extended for a period from about 8:00 a.m. to 4:30 p.m., with the latter part of the period reserved for poking and final burnout. Three modes of operation which incorporated various physical arrangements of paper and loading sequences were established and used; these are as follows:

(1) Mode 1

Pages of telephone books were crumpled individually, placed in large paper bags, and fed as fast as possible (in view of the burning rate and the burning-chamber capacity of each unit) from about 8:00 a.m. to 11:30 a.m. and from about 1:00 p.m. to 2:30 p.m. The charge was poked several times from about 3:00 p.m. until 4:15 p.m., when the gas was shut off. At about 4:30 p.m. and again the following morning, the weight of the unburned residue located in the combustion chamber and in the ash tray was determined.

(2) Mode 2

Packets, 1/4-in. thick, of telephone-book pages were stapled together at one corner and then torn into four quarters. A 5-lb stack of torn packets was fed initially into the 1-1/2-bushel units (30 lb in the 4-bushel unit). After burning was well established, 5-lb stacks were fed intermittently as needed to keep

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the combustion chamber nearly full. Feedings and subsequent poking were carried out under the same time schedule as described above under Mode 1.

(3) Mode 3

A single load of paper, without subsequent feedings, was burned in this mode of operation. Telephone-book pages were stacked flat in the combustion chamber; for the 1-1/2-bushel units, 20 lb of paper was loaded and for the 4-bushel unit, 50 lb. Burning proceeded undisturbed from about 8:00 a.m. until from about 1:00 to 3:00 p.m. (depending on the extent of burning), at which time poking was started.

In the few tests with miscellaneous file papers, the units were operated under Mode 2.

Incineration without the use of gas was also evaluated in five of the gas-fired units. In addition, one of the gas-fired units (Calcinator) was converted and operated on Liquid Petroleum gas (propane, LP, or bottled gas) in two test runs.

RESULTS OF EVALUATION\*

The most important performance factors for incinerators which are to be used for the destruction of classified papers and documents are

\*The data upon which this report is based may be found in Laboratory Record Books Nos. 15944 and 16209.

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considered to be (1) the rate of burning, (2) the completeness of destruction, and (3) the reliability of operation. Other contributing factors are (1) the degree of freedom from smoke or dust in the room, (2) the level of emission of smoke and fly ash in the flue gas, (3) the output of heat into the room, (4) safety as related to the hazards of touching hot exposed surfaces of the unit and as related to operation of the gas burner, (5) durability, and (6) convenience of operation in loading, igniting the burner and charge, and disposing of the ash.

The detailed data obtained in the test runs are presented in Table 1A of Appendix A. Table 1 is a summary of the pertinent results.

#### Domestic Gas-Fired Incinerators

##### Burning Rate

The first and second columns of Table 1 indicate the class and name of the incinerators, any auxiliary blower operation, and the gas-heat input when the gas burners were in operation. The next five columns show the average burning rates obtained in working-day-long burning tests under three modes of operation using crumpled, torn, or stacked pages of telephone books, and also other types of paper, with the draft inducer on in most cases, but off in a few cases for comparison purposes.

The five domestic units gave burning rates in the range of 1.4 to 7.4 lb per hr. These rates may be considered adequate in some cases for routine daily destruction; but, they would be inadequate for any mass destruction of large amounts of paper, on a routine basis and particularly on an emergency basis.

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TABLE 1. SUMMARY OF RESULTS OF INCINERATOR EVALUATION

Unit and Some Conditions of Test	Gas-Heat Input, Btu/hr	Average Burning Rate, lb per hr <sup>(a)</sup>				Draft Inducer Off - Node 2	Calculated Unburned Paper and Char at End of Day, lb <sup>(a)</sup>			Emission of Fly Ash, Smoke, and Odor Into Room	Temperature Rise of Room, °F <sup>(a,d)</sup>	
		Draft Inducer On					Node 1	Node 2	Node 3		Node 2	Node 3
		Node 1	Node 2	Node 3	Other							
<u>Domestic Gas-Fired Units, 1-1/2 bushel</u>												
1. Calcinator												
With natural gas	30,000	4.2	4.1	2.4	-	4.0	0	1.1	0.2	Slight	13	14
No gas	None	-	3.5	-	-	-	-	1.2	-	Slight	8	-
With LP (propane) gas	30,000	-	4.1	2.4	-	-	-	1.3	0	Slight	15	-
2. Martin, metal liner												
No blower; natural gas	33,000	4.9	3.7	2.2	-	-	-0.4 <sup>(e)</sup>	4.3	1.7	Slight	11	9
With blower; natural gas	33,000	-	7.4	3.3	-	-	-	-1.4 <sup>(e)</sup>	-0.6 <sup>(e)</sup>	High	17	11
No blower; no gas	None	-	2.4	-	-	-	-	4.6	-	V. slight	10	-
3. Martin, refractory lined												
No blower; natural gas	35,000	2.6	3.1	2.1	-	-	0.6	4.4	2.2	Slight	12	11
No blower; no gas	None	-	2.5	-	-	-	-	3.9	-	V. slight	8	-
4. Warm Morning												
With natural gas	10,000	3.9	3.7	1.4	6.2 <sup>(b)</sup>	3.7	0.4	4.1	7.6	V. slight	11	7
With natural gas	10,000	-	-	-	3.3 <sup>(c)</sup>	-	-	-	-	Slight	9	-
5. Caloric												
With natural gas	30,000	1.4	2.3	2.0	-	-	1.8	5.2	3.4	Slight	11	15
No gas	None	-	- <sup>(2)</sup>	-	-	-	-	-	-	-	-	-
<u>Special Paper Incinerator, 1-1/2 bushel</u>												
Silent Glow Confidential Paper Destroyer	None	13.6	9.7	7.5	-	-	0.3	0.5	0	Slight	15	-
<u>Small Commercial Incinerator, 4 bushel</u>												
Winsinator, natural-gas fired												
Both burners on; blower on	100,000	-	16.7	14.6	-	-	-	0 <sup>(e)</sup>	-0.7 <sup>(e)</sup>	V. slight	25	32
Grate burner on; blower on	45,000	37.4	31.7	-	29.7 <sup>(c)</sup>	-	-9.5 <sup>(e)</sup>	-2.0 <sup>(e)</sup>	-	V. slight	33	-
Both burners off; blower off	None	-	19.0	-	-	22.1	-	3.4	-	V. slight	20	-

Footnotes are listed on next page.

FROM: ARCHIVES/RECORDS CENTER		NO. 1888625	DATE 5 Dec. 80	BOX NUMBER 9	JOB NUMBER 73-3642A
		DATE SERVICED	ACTION REQUESTED		
			<input checked="" type="checkbox"/> LOAN	<input type="checkbox"/> PER. RETENT.	<input type="checkbox"/> INFORMATION
TO: OTS/RTO		NAME OF REQUESTER			
212 South Bldg.		STAT			
		(TCD Files for P.B.) STAT			
		OFFICE CTS		TEL. EXTENSION	
LOG DATA	MATERIAL REQUESTED IS TO BE USED FOR (check one)				
	<input type="checkbox"/> FOIA	<input type="checkbox"/> PRIVACY ACT	<input type="checkbox"/> COMMITTEE INVESTIGATIONS	<input type="checkbox"/> OTHER	
Folder: 5		FOR ARCHIVES/RECORDS CENTER USE			
		SERVICED BY	SPACE NUMBER	POSTED	
				STAT	
		NUMBER OF DOCUMENTS SENT		NOTIFIED	

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- (a) The standardized types of operation used in burning pages of telephone books are identified as follows: Mode 1 - crumpled pages in paper bags, fed intermittently; Mode 2 - thin packets of pages, torn into quarters, fed intermittently; Mode 3 - a single charge of stacked pages.
- (b) File cards, 5-1/2 x 8 in., were burned in this test.
- (c) Assorted file papers, 8-1/2 x 11-in. onionskin, Bond, and carbon paper, were burned in this test.
- (d) This represents the temperature rise in the test room as compared to a similar adjacent room which was also air conditioned with the same kind of window unit.
- (e) In all but one test with blower operation and in one test with crumpled paper, negative values were obtained in calculating the weight of unburned paper and char. This does not mean that the destruction was complete, but rather, that the fly-ash emission was high.
- (f) The Galerie unit sucked excessively into the room when attempts were made to operate it with the gas burner turned off.

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The lowest burning rates were obtained with the Caloric (1.4 to 2.3 lb per hr). Also, the Caloric was the only unit which did not operate satisfactorily when the gas burner was turned off; smoke leakage into the room was excessive. The highest rate, 7.4 lb per hr, was obtained during Mode 2 (torn packets, intermittently fed) operation of the metal-lined Martin unit with the manually powered blower in use; but, this was accompanied by an objectionable amount of leakage of fly ash into the room.

In the tests with the Calcinator, Warm Morning, and the two Martin units operated without blowers, burning rates of from 3.1 to 4.1 lb per hr were obtained for Mode 2 operation using gas. These units yielded only slightly lower burning rates of from 2.4 to 3.5 lb per hr when gas was not used. The burning rates obtained with Mode 1 (crumpled paper in bags, intermittently fed) operation were 2.6 to 4.9 lb per hr for these four units using gas. These rates were equal to or slightly higher, respectively, than those for Mode 2 operation under the same conditions in all but the refractory-lined Martin unit. Mode 3 operation (single charge of stacked sheets) gave the lowest burning rates obtained from these four units using gas, namely, from 1.4 to 2.4 lb per hr. The influence of the type and form of the paper on the burning rate was also shown by the relatively higher rate of 6.2 lb per hr for 5-1/2 x 8-in. file cards and lower rate of 3.3 lb per hr for a mixture of onionskin, Bond, and carbon paper, as compared to 3.7 lb per hr for similar operation on torn pages of telephone books in the Warm Morning unit.

For each unit, the rate of burning during the first hour of operation at the beginning of the day was always higher than the average

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burning rate for the daily test period. Further, for each succeeding hour the burning rate decreased, probably because of the accumulation of ash in the combustion chamber.

The use of LP (propane) gas instead of natural gas (mostly methane) in the Calcinator unit yielded no change in the burning rate or in any other observed aspect of performance. With the exception of the need to follow added safety precautions for the storage and use of cylinders of gas, LP gas appears to be as suitable as utility gas for use in the domestic gas-fired units. New units could readily be equipped at the factory with the proper burner orifice for LP gas or a smaller sized orifice could be installed quite easily in the field to provide for paper burning with LP gas.

#### Degree of Destruction

Table 1 also shows the calculated weights of unburned paper and char, on which the printing was still legible, that remained at the end of the day-long tests using the three modes of operation.

In the evaluation of the completeness of destruction, the weight of the unburned and charred paper was calculated by subtracting the known weight of ash contained in the paper (5.4 per cent for telephone-book paper) from the total weight of the residue (paper, char, and ash) which was on hand at the end of each day's run. This method of calculation gave fairly reliable values for the unburned and charred paper under conditions of negligible emission of fly ash, such as with Mode 2 and Mode 3 operation in units on which the blowers, if available, were not run and therefore did not agitate the charge. In some of the tests performed using all three modes of operation, the results indicated clearly that an appreciable weight of fly ash was discharged with the stack gas. In some

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of these cases, the weight of the final residue was less than the known weight of ash in the paper charged, and negative values for the final residue were obtained.

The residue of unburned paper and char at the end of each day's operation of the domestic units (up to several pounds) represented an appreciable amount of legible material which, under service conditions, could not be left unattended. Even in cases of low calculated amounts of unburned paper and char, the char and some of the unbroken ash could still be read, and further treatment, such as refiring or additional stirring and poking, was necessary in order to break up the residue. Under service conditions, the residue would have to be treated in this manner before it could safely be discarded for unclassified handling.

When such legible residue was left unmolested overnight in the unit, it generally continued to burn, and by the next morning, the weight of the residue had decreased; but, in no case was destruction of such legible material completed overnight in any of the incinerators included in this program. However, the Calcinator approached more closely the achievement of complete destruction by the end of the day's operation than did any of the other domestic units evaluated, as shown in Table 1.

#### Emission Into the Room

The emission or leakage of fly ash, smoke, and odor into the test room depended mainly on the operating procedure used. As long as the loading door was kept closed (Mode 3 operation), emission into the room was inoffensive. But, in the course of intermittent loading, especially of

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bags of crumpled paper, fly ash and some smoke and odor were emitted into the room. This condition, described in Table 1 as "slight" or "v. slight" (very slight), would undoubtedly be regarded as not too desirable in an office area, but probably would not be looked upon as completely objectionable, i.e., this condition might be considered tolerable. In the case of burning in the Martin unit with the blower operating, the emission of fly ash from around the closed loading door was definitely objectionable.

#### Room Heating

Under service conditions, perhaps a greater degree of discomfort in the room would stem from the heat given off by the incinerator and its flue pipe than from the emission of fly ash, smoke, and odor. Table 1 also indicates, for the domestic units, temperature rises of from 7 to 17 degrees F in the test room (as compared to a similar adjacent room, with both rooms air conditioned similarly). Contributing to this heating problem were the relatively high maximum temperatures of the exposed surfaces of the units and the high temperatures of the flue gas exiting through the stack. (See Table 1A, Appendix A, for details.) In addition to the rise in the temperature of the room air associated with the operation of these domestic units, the direct radiation from the hot surfaces to any nearby personnel would add to the discomfort unless reflective thermal-shielding panels were installed around the units.

#### Stack Emissions

Visual inspection of the flue gas discharged from the stack indicated that the emission of fly ash was very low from the new, improved, domestic units (Calcinator, Caloric, and both Martins without the blowers

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operating). It is judged that the corresponding levels of emission would present no difficulties in meeting the conventional regulatory codes for the emission of fly ash in most cities in the United States. However, when the Martins were run with the blowers operating, the amount of fly ash in the flue gases was objectionable. Visible smoke and smoke readings obtained using the Bacharach Smoke Meter were acceptably low for these four new, improved units, even when the blowers on the two Martin units were operating. Slightly more smoke and fly ash were observed in the stack gases from the old-type domestic unit (Warm Morning); these emissions were not objectionable.

Safety, Convenience, and  
Reliability of Operation

All of the domestic gas-fired units have continuously operating pilot lights for convenient ignition of the main burner and thus the charge. The safety shut-off feature incorporated in the timer control automatically shuts off all gas flow in the event that the gas flame is accidentally extinguished. For continuous operation over a period of several hours, however, the operator must reset the timer control periodically (every 2 to 4 hr, depending on the timer cycle of the unit) to avoid interruption of the main burner flame.

These domestic units are set up for top loading, which is convenient for quickly dropping stacks or bags of paper into the combustion chamber. Care must be exercised in feeding fast-burning material such as crumpled paper, however, as flames may extend above the unit when the door is opened. Models of these units that are equipped with foot pedals for opening the door provide added safety in this regard. In addition, the use

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of gloves is recommended, as the surfaces in the region of the door are usually too hot to touch with a bare hand.

In general, the reliability of operation of the domestic units was good. After initial adjustment of the gas-pilot flame, practically no trouble was experienced with outage of the flame. Of course, the usual precaution of emptying the ash tray before it overflows is important.

Reliability of operation over an extended period of time was not evaluated in this relatively short program. However, inspection of the parts and measurement of the temperatures of the hottest interior metal parts provided a basis for estimating life expectancy. In each unit, there are certain replaceable metal parts (burner canopy, baffle sheets, and screen or grid dividers) which are exposed to direct flame and are not subject to any cooling by outside air. These parts are made of mild steel and, during incineration, reached temperatures of up to 2000 F in the Calcinator, 1700 F in the Caloric, and 1350 to 1600 F in the two Martin units.

The Calcinator was operated for a total of about 70 hours, which was longer than were the total operating times for the other units. During this period, warpage developed in the grid and sheet-metal portions of the rear dividing wall of this unit; progressive scaling of the sheet metal also occurred (Figure 2). This extent of deterioration did not appear to alter the performance of the Calcinator. We anticipate that this part may need replacement after from 6 to 12 months of steady daily paper burning. It is also estimated that similar parts in the other domestic units may

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have to be replaced after about one year of steady service. However, it is expected that the grates, burners, and particularly the metal liner and rear gas passageway, which are not easily replaced, would be capable of withstanding from 3 to 5 years of steady use. The refractory liners of the one Martin unit and the Waco Morning would be expected to last somewhat longer.

#### Silent Glow Special Paper Destroyer

Table 1 also summarizes the results obtained with the 1-1/2-bushel Silent Glow Confidential Paper Destroyer which does not use supplementary gaseous fuel. Average daily burning rates of from 7.5 to 13.6 lb per hr were obtained for the three modes of operation. This was 2 to 3 times the average burning rates obtained in the domestic gas-fired units, and compared favorably with the rates described in the manufacturer's Information Bulletin No. 10.

The degree of destruction in the Silent Glow was somewhat better than that obtained in the domestic units. However, complete destruction was not obtained even after the residue was allowed to remain overnight in the unit. An advantage over the domestic units in this respect would stem from the fact that all of the openings in this unit were set up to be padlocked, if desired. This feature would permit leaving the residue in the unit overnight and then continuing the destruction along with the next new charge, thus, in many instances, eliminating the necessity of removing all of the dusty residue from the unit at the end of the working day. In the morning, the loose ash could be discharged to the ash tray

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by shaking the grates and only this ash would have to be removed daily from the unit. In addition, under service conditions, it would be worth while to periodically remove fly ash and bits of char through the normally padlocked access door of the rear settling chamber.

During charging, the room emissions of fly ash, smoke, and odor from the operating Silent Glow were about the same as those from the domestic units. The front loading door, however, was not so convenient as was the top-loading door in the domestic units, and more ash sifted onto the floor from the lower sill of the front loading door than was emitted into the room from the top-loading doors of the domestic units. The rate of burning for single, full loads (Mode 3) was reasonably close to that for intermittent feeding of uncrumpled paper (Mode 2). Therefore, it would be advisable, in service, to use the single, full-load method with the Silent Glow and benefit from reduced room emissions.

Room heating (temperature rise of 15 F) stemming from paper burning in the Silent Glow caused about the same degree of discomfort as that from the domestic units. Some of the exposed surfaces were also too hot to touch. Stack emissions appeared to be slightly higher than those from the domestic units, but probably were not in excess of the limitations imposed by the smoke- or fly-ash-emission codes of most cities in the United States.

Because of its simplicity and independence relative to supplementary fuel, the Silent Glow is rated high in reliability of operation. The cast iron grates would last for many years. The only other metal part contacted by flames is the replaceable, stainless steel, perforated tube in the rear chamber. This reached a maximum temperature of about 1500 F; therefore, it is unlikely that replacement of this part would be necessary for several

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years. The cast refractory lining and perforated dividing wall developed a few shrinkage cracks, and close observation showed a slight degree of spalling. In general, however, cast refractory construction of this type under similar operating conditions would have a life expectancy of about 5 years. Yearly inspection and repair with a refractory wash coat or cement would constitute conventional maintenance practice for this type of construction.

#### Small, Commercial Gas-Fired Incinerator (Wincinator)

The 4-bushel Wincinator unit yielded a rather wide range of burning rates, from 14.6 to 37.4 lb per hr, under the different operating conditions selected, as summarized in Table 1. It may seem surprising that the lower burning rates were obtained with the highest gas-heat input of 100,000 Btu per hr. However, this can be reconciled by the fact that the flow of air from the side-mounted blower (part of the power burner) had to be adjusted to a relatively low rate in order to obtain a stable flame in the power burner, whereas when the blower for the power burner was used to deliver only air, the air throttle was adjusted to the "wide open" condition.

The power burner is a desirable accessory for the incineration of wet wastes such as garbage; but, for the incineration of dry paper, a simple air blower could advantageously be substituted for the power burner. The use of the under-grate burner was beneficial in the achievement of more complete destruction of the final residue. As expected, the unit performed at a reduced burning rate of 19 lb per hr when both gas burners were turned off.

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The capacity rating given in the manufacturer's literature for the Model C2-4 Wincinator is 75 lb per hr based on burning half wet and half dry refuse when the incinerator is equipped with a pressurized gas burner as in this case. The maximum burning rate obtained with dry paper in this evaluation, however, was only 37.4 lb per hr. The average burning rates for Mode 2 operation of the Wincinator were about 8 times those of the domestic units and about 3 times that of the Silent Glow.

Because of fly-ash losses as a result of the blower operation, the calculated weights of unburned paper and char (Table 1) were not a reliable indication of the degree of destruction. Other observations in regard to the legibility of the residue (Table 1A of Appendix A) showed that destruction was not complete, but was as good as in the best of the other units in this respect when the blower was operated. Because of the larger amount of paper burned per day in the Wincinator, the amount of unburned residue represented a smaller percentage of the total charge than was the case for the other units.

With respect to emission of fly ash, smoke, and odor into the room during loading, the Wincinator gave cleaner operation than did the other units as long as the blower was turned off momentarily during loading. The lever-operated loading door permitted quick feeding action; also, there was always a flow of room air into the unit, as a result of provision for good draft, which prevented the flame and gases from rising out of the door opening. The only source of dust into the room, except when the ash tray was being unloaded, was the opening for the power burner in the side of the unit. During periods when the charge level was above this opening, fly ash sifted from this opening onto the floor whenever the blower was turned off for loading.

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Operation of the Wincinator in typical, small office space would, indeed, present a problem of discomfort from excessively high room temperature and direct radiation; the temperature rise associated with the operation of this unit ranged from 20 to 33 F in an air-conditioned room. This factor alone indicates that this type of incinerator would not be suitable for daily use in an office unless special provisions for shielding and dissipating the heat were included in the installation.

The emission of fly ash in the stack gas was greater during blower operation of the Wincinator than was that from the other units. Although this emission might possibly be acceptable from the user's standpoint, it is doubtful that it would pass emission codes in the major cities of the United States.

The hottest exposed surfaces of the Wincinator were on the unlined loading doors, where temperatures of 700 to 1000 F were noted. This was relatively hazardous even though the door was equipped with a long handle. The two halves of the cast iron door did not fit together properly when the unit was received, and warpage from the heat during operation caused further misfit, which required modification in order to permit continued operation. Aside from this difficulty, which the manufacturer could easily remedy, the unit was generally reliable in operation. Both gas burners were equipped with safety shut-off pilots.

Nearly all of the structure of the Wincinator is refractory lined, including the passageway for the hot flue gas in the ash settling chamber. Cast iron is used for the loading doors and grates, and no other metal parts are exposed to high temperatures. Therefore, it is estimated that the unit would have a life expectancy of at least 5 years.

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3. Hein, G. M., and Englehl, R. B., "A Study of Effluents From Domestic Gas-Fired Incinerators", American Gas Association, Inc., New York, June, 1959.
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APPENDIX

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TABLE 1A. DETAILED DATA AND RESULTS FROM INDIVIDUAL TEST RUNS

Test No.:	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57				
Unit:	Warm Morning									Calculator				Caloric				Martin 5-598				Martin 4416				Sifert Glow				Winclator				Calculator (LP Gas)													
Gas-Heat Inpt, Blower	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	30,000	28,000	28,000	30,000	No gas	No gas	30,000	30,500	30,000	35,000	35,000	35,000	35,000	No gas	33,000	33,000	33,000	33,000	33,000	No gas	-	-	-	-	100,000	100,000	No gas	41,000	No gas	44,000	45,000	30,000	30,000					
Combustion Air Blower, on or off	On	On	On	On	On	On	On	On	On	Off	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On			
Induced-Drift Fan, on or off	On	On	On	On	On	On	On	On	On	Off	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On			
Draft at Flue Collar, in. H <sub>2</sub> O	0.035	0.038	0.035	0.038	0.042	0.036	0.035	0.022	0.018	0.019	0.025	0.027	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.027	0.030	0.028	0.027	0.029	0.032	0.032	0.045	0.043	0.056	0.058	0.054	0.048	0.056	0.072	0.053	0.064	0.058	0.030	0.051				
Operating Mode <sup>1)</sup>	2	1	3	2	2c	2b	1a	2d	2	2	1	2	3	2	2T	2	1	3	2T	2	3	1	2	2T	3	3	2	2	1	2	2T	3	1	2	2T	3	2	2	2	2b	1	2	3				
Weight of Initial Load, lb	5.0	0.7	20.0	11.3	14.75	5.3	0.5	11.3	5.0	5.0	0.8	5.0	20.0	5.0	5.0	5.0	0.7	20.0	11.3	14.75	5.3	0.5	11.3	5.0	5.0	0.8	5.0	20.0	11.3	14.75	5.3	0.5	11.3	5.0	5.0	0.8	5.0	20.0	11.3	14.75	5.3	0.5	11.3	5.0	5.0	0.8	5.0
Additional Feedings, No. of times	6X	51X	None	6X	7X	5X	42X	7X	6X	6X	39X	6X	None	5X	-	4X	14X	None	1X	5X	None	29X	4X	4X	None	None	10X	6X	43X	4X	11X	None	39X	15X	18X	None	26X	44X	31X	44X	287X	6X	None				
Total Weight Charged, lb	35.0	33.0	20.0	44.9	57.5	31.8	23.7	44.0	35.0	35.0	34.8	35.0	20.0	30.0	-	25.0	13.2	20.0	-	30.0	20.0	22.0	25.0	25.0	20.0	20.0	15	35	40	25.0	56.5	20.5	40.9	80.0	120.0	50.0	160.0	250.0	185.0	250.0	288.0	35.0	20.0				
Total Loss in Weight, lb	28.8	30.8	11.3	38.6	48.3	26.1	22.2	36.0	29.0	31.3	33.0	32.0	18.7	27.2	-	18.2	10.7	15.5	-	24.0	16.8	28.2	19.8	20.5	17.2	19.5	53.5	28.8	38.2	19.0	53.3	20.0	38.4	75.2	113.5	48.0	148.0	236.5	172.0	231.0	212.1	31.8	19.0				
Period of Operation, min	488	495	495	495	495	503	495	495	495	495	495	495	495	495	-	495	495	495	120	495	495	495	495	345	495	373	463	495	495	495	375	170	180	495	435	210	495	480	495	495	480	495	495	495			
Burner Rate, lb/hr	Average	3.7	3.9	1.4	4.9	6.2	3.3	2.8	4.7	3.7	4.0	4.2	4.1	2.4	3.5	-	2.3	1.4	2.0	-	3.1	2.1	2.6	2.5	3.8	2.2	3.3	7.4	3.7	4.9	2.4	9.0	7.5	13.6	6.7	16.7	14.6	19.0	31.7	22.1	29.7	37.4	4.1	2.4			
During First Hour	4.5	7.3	2.5	8.0	9.0	5.5	4.7	5.3	4.5	7.8	4.1	8.8	5.8	5.3	-	3.5	3.2	4.0	-	5.8	3.8	4.0	2.5	5.0	7.7	7.2	9.3	5.5	12.0	3.8	13.0	12.0	16.5	15.5	-	-	-	-	-	-	-	-	7.0	5.0			
During Second Hour	3.5	9.1	1.3	8.5	7.5	-	6.0	4.0	8.7	5.5	3.5	3.9	5.0	3.5	4.5	-	2.2	2.2	3.0	-	4.0	3.3	3.2	3.5	-	2.0	5.7	9.5	5.7	8.3	4.5	12.0	7.5	11.0	11.5	-	-	-	-	-	-	-	-	5.8	3.5		
Residue	Total Weight at End of Day, lb	6.2	2.2	8.7	6.2	9.2	5.7	10	8.0	6.0	3.7	1.8	3.0	1.3	2.8	-	6.8	2.5	4.5	-	6.0	3.3	1.8	5.3	4.5	2.8	0.5	1.5	6.2	1.8	6.0	3.2	0.5	2.5	4.8	6.5	2.0	12.0	11.5	13.0	19.0	6.8	3.2	1.9			
Total Weight by Following Morning, lb	-	-	-	-	-	-	-	-	-	-	2.2	1.7	1.8	2.0	1.3	2.0	-	2.3	1.8	1.8	2.5	1.5	1.3	0.5	1.5	2.4	-	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0	-		
In Ash Tray, lb	2.5	1/2	0.2	0.6	0.5	0.6	0.6	0.6	0.5	0.7	0.4	0.4	0.6	0.2	-	0.2	0.3	0.2	-	0.5	0.3	0.6	0.3	0.2	0.4	0.5	1.5	0.3	1.5	0.2	1.2	<0.1	0.1	1.1	Nil	Nil	Nil	Nil	Nil	Nil	0.6	0.2					
In Ash Tray, fraction of tray volume	1/4	1/2	-	1/2	1/2	2/3	1/3	1/2	1/2	Full	3/4	3/4	3/4	1/300	-	1/4	1/3	1/5	-	1/2	2/3	3/4	1/2	1/4	1/3	3/4	2	1/3	3/2	1/5	1	-	-	1/2	-	-	-	-	-	-	-	-	1/2	1/4			
In Ash Tray, est. per cent legible	10	20	1	50	80	75	1	60	80	10	5	5	5	10	80	-	80	10	5	-	80	80	70	90	70	95	95	90	30	15	99	1	5	1	1	1	0	0	0	0	0	0	0	2	5		
In Combustion Chamber, lb	3.7	0.5	8.5	5.6	8.7	5.1	6.4	7.5	5.5	3.0	1.3	2.6	0.7	2.6	-	6.6	2.2	4.3	-	5.5	3.0	1.2	5.0	4.3	2.4	0	0	5.9	0.3	5.8	Poked all	0.5	2.4	3.7	6.5	2.0	12.0	11.5	13.0	19.0	6.8	2.6	0.8				
In Combustion Chamber, fraction of chamber volume	3/4	-	-	-	-	-	-	-	1/2	3/4	1/2	1/2	1/2	1/2	-	4/5	2/3	1/2	2/3	1/2	1/3	0	0	2/3	1/5	3/4	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1/4	1/5		
In Combustion Chamber, est. per cent legible	80	90	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	-	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	>50	-	-	>50	30	>50	5	5	>60	>60	2	20	80	10	90	50	<1	>50				
Residue Minus Ash, lb	4.3	0.6	7.6	3.5	6.1	4.0	0	5.6	4.1	1.8	0	1.1	0.2	1.2	-	5.2	1.8	3.4	-	4.4	2.2	0.6	3.9	-	1.7	-0.6	-1.4	4.3	-0.4	4.6	0.2	0	0.3	0.5	0	-0.7	3.4	-2.0	3.0	5.5	-0.5	1.3	0				
Stack Emission	3X	41X	None	12X	6X	9X	3X	6X	5X	7X	15X	10X	4X	4X	-	None	3X	5X	3X	None	3X	5X	5X	3X	4X	4X	5X	24X	4X	20X	3X	12X	4X	3X	3X	8X	10X	4X	25X	25X	32X	45X	288X	3X	None		
Visible Fly Ash, no. of times	5X	3X	1X	3X	2X	3X	25X	8X	7X	None	None	None	None	5X	-	None	1X	1X	None	-	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Visible Smoke, no. of times	5X	41X	None	3X	2X	3X	25X	8X	7X	None	None	None	None	5X	-	None	1X	1X	None	-	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Smoke No. (2)	1-4	1-8	1-3	1-4	1-4	1-5	1-7	1-6	1-3	1-3	2-6	1-5	0-1	0-5	-	1-3	0-2	1-2	-	1-2	1	1-3	1-3	1-3	0-1	0-1	0-4	0-2	1-4	1-2	2-4	1-2	3-6	2-5	0-2	0	1-4	0-1	1-2	0-5	3-5	0-3	0	0			
Color, no. of times	2X	1X	2X	3X	1X	5X	5X	7X	9X	1X	3X	2X	1X	7X	-	Some	2X	1X	None	-	1X	1X	1X	12X	1X	1X	None	1X	None	1X	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Smoke With Lid Open	None	None	None	None	None	2X	Some	Some	Some	None	2X	6X	1X	-	3X	-	Some	7X	14X	-	1X	-	1X	None	-	-	-	-	2X	15X	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Smoke With Lid Closed	None	None	None	None	None	None	None	None	None	None	7X	1X	None	1X	-	Some	None	None	None	-	1X	None	1X	1X	-	-	-	-	None	Fly ash	Fly ash	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	
Other	None	None	None	None	None	None	2X	Some	Some	None	2X	3X	None	None	3X	-	Some	7X	14X	-	1X	None	None	1X	-	-	-	-	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Temperatures, F	Maximum	1180	1095	485	1190	1220	1270	1380	1000	1310	930	1610	1410	820	825	-	595	600	580	-	885	700	1020	360	980	740	1070	1320	930	1450	365	720	870	1090	1160	1620	1070	1490	1770	1545	1770	1780	810	735			
Hottest Interior Metal	Average	440	750	250	480	570	390	480	520	385	740	770	750	740	300	-	520	520	500	-	715	650	710	210	730	630	650	990	750	900	187	430	475	695	615	1025	430	475	695	615	1025	430	475	695	615		
Hottest Exposed Surface	Maximum	-	-	-	-	-	-	-	-	-	1770	2000	1980	1970	1250	-	1630	1625	1675	-	-	-	1350	770	1470	1440	1390	1620	1490	1590	470	1245	1215	1450	1515	-	-	-	-	-	-	-	-	-	1800+	1800+	
Average	450	520	205	555	520	420	420	585	475	350																																					

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Footnotes to Table 1A

## (1) Operating Modes are identified as follows:

Mode 1: Crumpled telephone-book pages in bags; fed intermittently.

Mode 2: Packets of telephone-book pages, 1/4 in. thick, torn into quarters; fed intermittently.

Mode 3: Single change of stacked telephone-book pages.

Mode 1A: Crumpled telephone-book pages, loose; fed intermittently.

Mode 2A: Cigarettes, wood, and carbon papers handled in accord with Mode 2.

Mode 2B: File cards, 5 by 8 in.; fed intermittently.

Mode 2C: Packets of telephone-book pages, 1/4 in. thick, rolled up, inserted in bags; fed intermittently.

Mode 2D: An exploratory test, in which the loading was performed in accord with Mode 2.

- (2) The Bacharach Smoke Meter measures the concentration of smoke and soot by drawing a prescribed volume of flue gas through a fixed spot in a piece of white filter paper. The discoloration or darkening of this spot by particles of smoke and soot is then rated by matching the spot with one of ten consecutively numbered shades of gray printed on the Bacharach Smoke Scale. No. 0 represents no smoke (no discoloration) and No. 9 represents the highest concentration within the range of the instrument. Bacharach Smoke No. 5 represents a concentration of smoke which is barely detectable when viewed against the open sky. Readings not in excess of No. 4 for not more than 10 consecutive minutes are acceptable under the American Standards Association Approval Requirements.

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APPENDIX BList of Manufacturers to Whom Inquiries Were Sent

- (1) Artogas Company, 1100 South 25th Avenue, Bellwood, Illinois
- (2) Eastman-Morley Company, 200-300 Truesdell Avenue, La Porte, Indiana
- (3) Blue Ray Gas Burner Company, 1305 East Vernor Highway, Detroit, Michigan
- (4) Brule Incinerators, 13920 S. Western Avenue, Blue Island, Illinois
- (5) Calcinator Corporation, 28th and Water Streets, Bay City, Michigan
- (6) Caloric Appliance Corporation, Widener Building, Topton, Pennsylvania
- (7) Corosire Heater Corporation, 1422 Euclid Avenue, Cleveland 15, Ohio  
(No reply)
- (8) Dornback Furnace and Foundry Company, 1523 East 45th Street, Cleveland 3, Ohio
- (9) Godar, Joseph, 4241 North Honore Street, Chicago, Illinois
- (10) Incineration Division, Bowser, Inc., 4209 Sycamore Street, Cairo, Illinois  
(Incineration Division has discontinued manufacturing gas-fired incinerators)
- (11) Incinerator Products Company, 633 S. Post Street, Detroit 17, Michigan
- (12) Kerner Incinerator Division of Morse Boulder Destructor Company, 80 Fifth Avenue, New York 11, New York
- (13) Locke Stove Company, 114 West 11th Street, Kansas City 5, Missouri
- (14) The Majestic Company, Inc., 245 Erie Street, Huntington, Indiana
- (15) Martin Stamping and Stove Company, 3414 Governors Drive, Huntsville, Alabama
- (16) Modern Controls Corporation, 24,396 Wound Road, Center Line, Michigan  
(No reply)
- (17) Motor Wheel Corporation, Lansing 3, Michigan
- (18) Oakland Foundry Company, Belleville, Illinois

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- (19) Queen Products Division of King-Sealey Corporation, 505 Front Street,  
Albert Lea, Minnesota
- (20) Remor Manufacturing Company, 1939 David Street, Mercer, Pennsylvania  
(No reply)
- (21) George D. Roper Corporation, 2207 W. Station Street, Kankakee, Illinois
- (22) Silent Glow Corporation, 850 Windsor Street, Hartford 1, Connecticut
- (23) Waste King Corporation, Incinerator Division, 3300 East Fiftieth Street,  
Los Angeles 58, California
- (24) Wimmer Incinerator Company, 932 Broadway, Bedford, Ohio

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